PLANT ITEM MATERIAL SELECTION DATA SHEET

ISSUED BY
RPP-WTP PDC

R10667872

CXP-VSL-00001 (PTF)
Cs Ion Exchange Feed Vessel

- Design Temperature (°F)(max/min): 138/40
- Design Pressure (psig) (internal/external): 15/10
- Location: incell

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Maintenance will not be performed on this vessel for the forty years design life

Operating Modes Considered:

- The vessel is filled with LAW.
- The vessel is filled with demineralized water.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00		X
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 316 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- Develop rinsing/flushing procedure for acid and water.

STEVEN WAKEMAN VAIL
STATE OF WASHINGTON
39250
REGISTERED PROFESSIONAL ENGINEER
3/8/06
EXPIRES: 12/07/07

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This bound document contains a total of 6 sheets.

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Corrosion Considerations:

This vessel normally receives filtered LAW from one of the ultrafilter permeate vessels (UFP-VSL-000062A/B/C), as well as batches of pre-elution displaced LAW from the ion exchange column, and provides feed buffer capacity to allow continuous operation of the IX system.

a General Corrosion
Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 µm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect.

In this system, the normal hydroxide concentrations and temperatures are such that either 304L or 316L stainless steel will be acceptable.

Conclusion:
At temperatures less than about 140°F, 304L and 316L are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. If the chloride concentrations are low at the low pH and high at the high pH, then even the low pH conditions are expected to be benign towards 304L.

Normally the vessel is to operate between 77 and 113 °F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions.

If the vessel were rinsed with acid or filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the amount of residual chlorides. The more pitting-resistant 316L is recommended.

Conclusion:
Localized corrosion, such as pitting, is not a concern. It is expected that 316L will be a better choice than 304L.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F. During the normal operations, either 304L or 316L are expected to be satisfactory.

Neither 304L nor 316L are susceptible to caustic cracking at the proposed conditions.

Conclusion:
At the normal operating environment, either 304L or 316L is recommended.

e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

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g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth if microbes were introduced.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Not expected to be a concern.

Conclusions
Not a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is unknown whether this will be sufficiently washed or whether residual acids or solids will be present. Due to the possibility that deposits may remain, 316L is the minimum recommended.

Conclusion:
Not expected to be a concern with 316L.

j Erosion
Erosion of vessel should be minimal with the very low undissolved solids content anticipated. Erosion allowance of 0.004 inch for components with low solids content (< 2 wt%) at low velocities is based on 24590-WTP-RPT-M-04-0008.

Conclusion:
Not expeoted to be a concern.

k Galling of Moving Surfaces
There are no moving surfaces within the vessel.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

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References:

1. 24590-WTP-RPT-M-04-0008, Rev. 2, *Evaluation Of Stainless Steel Wear Rates In WTP Waste Streams At Low Velocities*
2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. CCN 130173, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
4. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073.
5. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073.
6. Hamner, NE, 1981, *Corrosion Data Survey*, Metals Section, 5th Ed, NACE International, Houston, TX 77218.
7. Koch, GH, 1995, *Localized Corrosion in Halides Other Than Chlorides*, MTI Pub No. 41, Materials Technology Institute of the Chemical Process Industries, Inc, St Louis, MO 63141.
8. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158.
9. Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.

Bibliography:

1. CCN 130171, Ohl, PC to PG Johnson, Internal Memo, Westinghouse Hanford Co, *Technical Bases for Cl- and pH Limits for Liquid Waste Tank Cars*, MA: PCO:90/01, January 16, 1990.
2. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073.
3. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158.
4. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084.

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PROCESS CORROSION DATA

Component(s) (Name/ID #) Cs ion exchange feed vessel (CXP-VSL-00001)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l	3.15E+01	3.17E+01			
Chloride	g/l	1.21E+01	1.45E+01			
Fluoride	g/l	1.44E+01	1.73E+01			
Iron	g/l	2.31E+00	2.60E+00			
Nitrate	g/l	2.23E+02	2.59E+02			
Nitrite	g/l	6.69E+01	8.01E+01			
Phosphate	g/l	4.83E+01	5.66E+01			
Sulfate	g/l	2.57E+01	3.08E+01			
Mercury	g/l	7.47E-02	1.94E-02			
Carbonate	g/l	9.03E+01	9.93E+01			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Note3
Temperature	°F					Note 2

List of Organic Species:

References

System Description: 24590-PTF-3YD-CXP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CXP09, UFP33, CXP01
Off Normal Input Stream #: off spec treated LAW high in Cs
P&ID: N/A
PFD: 24590-PTF-M5-V17T-P0012, Rev 0
Technical Reports: N/A

Notes:

1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. T operation 77 °F to 113 °F (24590-PTF-MVC-CXP-00001, Rev 0)
3. pH approximately 12 (based on $Al(OH)_3$ precipitation) to 14, CXP09, UFP33 are highly basic, contain 0.25M NaOH.

Assumptions:

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4.3.3 Cs Ion Exchange Feed Vessel (CXP-VSL-00001)

Routine Operations

The Cs ion exchange feed vessel (CXP-VSL-00001) is designed to receive LAW from the ultrafiltration process system (UFP) and provide feed buffer capacity to allow continuous operation of the IX system. The vessel normally receives filtered LAW from one of the three ultrafilter permeate vessels (UFP-VSL-00062-A, -B, or -C), as well as batches of pre-elution displaced LAW from the ion exchange columns. It can receive (intermittently) LAW that bypasses the ultrafilters (from UFP-VSL-00001-A or -B) and off-specification recycle from the Cs treated LAW collection vessel. The total batch volume of the Cs-IX feed vessel is 80,000 gallons.

Non-Routine Operations that Could Affect Corrosion/Erosion

This vessel is also used as a point of recycle for the IX system if the Cs treated LAW is found to be out of specification for ^{137}Cs content. This vessel overflows to PWD-VSL-00033. For corrosion evaluation, the recycle stream is bounded by the feed stream.